

REMARKS

In an Office Action mailed September 2, 2003, the Examiner has: (i) rejected claims 65-85 under 35 U.S.C. §112, second paragraph, as being indefinite, ii) objected to claims 65-85 under 37 CFR 1.75(c) as being of improper dependent form, iii) rejected claims 65-70 under 35 U.S.C. §102(b) as being anticipated by Chapman et al. (U.S. Pat. 5,053,434), and (iv) rejected claims 65-85 under 35 U.S.C. §102(b) as being anticipated by WO 92/13909 to Mobil Oil.

In this response, claims 65-69 have been rewritten in independent form, and claims 72, 75 and 83 have been amended merely to improve a minor issue of grammar (addition of the word “and” after the penultimate member of a string of elements). No claims have been canceled. Thus, claims 65-85 are pending.

Turning now to the rejections and objections of record, and the Applicants' response thereto:

Section 112 Rejections

35 U.S.C. §112, second paragraph

The Examiner has rejected claims 65-85 under 35 U.S.C. §112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention. Clarification was requested with regard to the term “higher” diamondoid.

As discussed in the specification at paragraph [00083] on page 12 to paragraph [00085] on page 13, among other places, “diamondoids” include “lower diamondoids” and “higher diamondoids.” As defined therein, the term “lower diamondoids” refers to adamantane, diamantane, and triamantane, including any or all unsubstituted and substituted derivatives of these compounds. In contrast, the term “higher diamondoids” is defined to refer to any and/or all substituted and unsubstituted tetramantanes, pentamantanes, hexamantanes, heptamantanes,

octamantanes, nonamantanes, decamantanes, and undecamantanes, including isomers and stereoisomers, thereof.

Thus it is believed that the term "higher" as used in claims 65-85 is defined in the specification, and that the specification does provide a standard for one of ordinary skill in the art to reasonably apprise the scope of the invention.

37 CFR 1.75(c)

Additionally, the Examiner has objected to claims 65-85 under 37 CFR 1.75(c) as being of improper dependent form, requiring Applicants to either cancel the claims, amend the claims to place them in proper dependent form, or rewrite the claims in independent form.

In this response, claims 65, 66, 67, 68, and 69 have been rewritten in independent form, and thus they no longer depend from withdrawn claims 1, 2, 5, 6, 16, respectively. Since claim 70 is an independent claim and does not depend from any withdrawn claim, and since claims 71-77 depend from claim 70, claims 71-77 have not been rewritten in independent form. Similarly, since claim 78 is an independent claim and does not depend from any withdrawn claim, and since claims 79-85 depend (either directly or indirectly) from claim 78, claims 79-85 have not been rewritten in independent form.

Favorable reconsideration and withdrawal of the Examiner's Section 112 rejections of claims 65-85 are therefore respectfully requested.

Section 102(b) Rejections

Chapman et al. (U.S. Pat. 5,053,434)

The Examiner has rejected claims 65-70 under 35 U.S.C. §102(b) as being anticipated by Chapman et al. (U.S. Pat. 5,053,434). For the following reasons, favorable reconsideration of the rejections is respectfully requested.

The Chapman et al. reference is directed to polymers comprising adamantane. Disclosed are linear adamantane rod homopolymers (cols. 7-8), zig-zag adamantane homopolymers (cols. 8-9), adamantane dimers (Example I), adamantane trimers (Example II), cyclic adamantane tetramers (Examples III and IV), adamantane pentamers (Example VII), adamantane heptamers (Example VIII), sheet structures from adamantane dimers (Example X), and helical adamantane homopolymers (Example XII), to name just a few examples.

Adamantane is the smallest of the lower diamondoids, and it is not one of the higher diamondoids of the instantly claimed polymers. Therefore, it is submitted that claims 65-70 are not anticipated by Chapman et al. (U.S. Pat. 5,053,434). Furthermore, it is submitted that claims 65-70 are not rendered obvious by Chapman et al. because of the vastly more complex nature of the higher diamondoids relative to the lower diamondoids. This will be explained in more detail in the following discussion pertaining to the WO 92/13909 reference.

Favorable reconsideration and withdrawal of the Examiner's rejections of claims 65-70 over Chapman et al. are therefore respectfully requested.

WO 92/13909 to Mobil Oil

The Examiner has rejected claims 65-85 under 35 U.S.C. §102(b) as being anticipated by WO 92/13909 to Mobil Oil. For the following reasons, favorable reconsideration of the rejections is respectfully requested.

WO 92/13909 discloses a polymeric composition comprising at least one monomer which has the structure of diamantane, triamantane or a higher adamantane analog and which is bonded through at least one double bond extending through a methylene position of said monomer. See Abstract. The most preferred synthesis technique for all of the diamondoid polymers of the WO 92/13909 disclosure is a two-step synthesis involving first an oxidation step to form at least one ketone at a methylene position of a diamondoid monomer, and then a second step consisting of coupling two or more ketones to produce the desired polymer. See page 24, line 22 to page 25, line 2.

The WO 92/13909 reference defines “adamantalogs” as being molecules having a backbone resembling that of the diamond structure, and consisting of polycyclic carbon rings such as adamantane, diamantane, triamantane, and alkyl substituted derivatives of the “higher adamantane homologs.” Furthermore, “homologous series of adamantalogs” is defined as compounds that may be “represented by the formula $C_6H_{10} + 4(C_nH_n)$, where n ranges from 1 to greater than 10 and is most commonly from 1 to 3.” The WO 92/13909 reference further states that “the formula represents adamantane when n=1, diamantane when n=2, and triamantane when n=3.” See page 1 of the WO 92/13909 reference, lines 15-27.

Applicants note that the adamantalog formula of the WO 92/13909 reference appears to be taking into account a deficiency of two hydrogens that will result with the creation of a double bond from any one of the methylene carbons of the adamantalog molecule, such as would happen during the oxidation step of the adamantalog to a ketone (see the reference’s preferred method of synthesis, described above). For example, the adamantalog formula predicts stoichiometries of $C_{10}H_{14}$, $C_{14}H_{18}$, and $C_{18}H_{22}$ for the compounds adamantane, diamantane, and triamantane, respectively, whereas the actual stoichiometries are $C_{10}H_{16}$, $C_{14}H_{20}$, and $C_{18}H_{24}$. That notwithstanding, it is submitted that the adamantalog formula of the WO 92/13909 reference still does not describe the stoichiometries of the “adamantalogs” higher than tetramantane. Moreover, the adamantalog formula is only theoretical at best, and clearly does not put into the possession of the public the higher diamondoids of the instantly claimed polymers.

An example of the incomplete stoichiometric descriptions provided by the WO 92/13909 adamantalog formula may be seen with reference to the table below:

Number of cage units	Number of molecular formulae	Higher diamondoid	Stoichiometric formula							
			C ₂₂ H ₂₈	-	-	-	-	-	-	-
4	1	Tetramantane	C ₂₂ H ₂₈	-	-	-	-	-	-	-
5	2	Pentamantane	C ₂₆ H ₃₂	C ₂₅ H ₃₀	-	-	-	-	-	-
6	3	Hexamantane	C ₃₀ H ₃₆	C ₂₉ H ₃₄	C ₂₆ H ₃₀	-	-	-	-	-
7	4	Heptamantane	C ₃₄ H ₄₀	C ₃₃ H ₃₈	C ₃₂ H ₃₆	C ₃₀ H ₃₄	-	-	-	-
8	5	Octamantane	C ₃₈ H ₄₄	C ₃₇ H ₄₂	C ₃₆ H ₄₀	C ₃₄ H ₃₈	C ₃₃ H ₃₆	-	-	-
9	6	Nonamantane	C ₄₂ H ₄₈	C ₄₁ H ₄₆	C ₄₀ H ₄₄	C ₃₈ H ₄₂	C ₃₇ H ₄₀	C ₃₄ H ₃₆	-	-
10	7	Decamantane	C ₄₆ H ₅₂	C ₄₅ H ₅₀	C ₄₄ H ₄₈	C ₄₂ H ₄₆	C ₄₁ H ₄₄	C ₃₈ H ₄₀	C ₃₅ H ₃₆	-

The adamantalog formula does more or less correctly describe the stoichiometry of the four tetramantanes, which is actually C₂₂H₂₈, although the formula predicts C₂₂H₂₆ for the reasons noted above. However, the formula predicts only one of the pentamantane stoichiometries, C₂₆H₃₀ (it should really be C₂₆H₃₂), and *fails to predict* another of the pentamantanes, C₂₅H₃₀. Likewise, the adamantalog formula predicts only one of the hexamantane stoichiometries, C₃₀H₃₄ (actually it is C₃₀H₃₆), but this time fails to predict *two other* stoichiometries, C₂₉H₃₄ and C₂₆H₃₀. The inability of the adamantalog formula to predict stoichiometries is compounded even further as one goes to higher values of "n," missing three of the heptamantane stoichiometries, four of the hexamantanes, and so on.

In fact, the differences between the lower diamondoids adamantane, diamantane, and triamantane, and the higher diamondoids of the instantly claimed polymers, are vast. These differences become clear when comparing how lower and higher diamondoids may be described in relation to the following categories: 1) the number of isomers per family, and whether or not chirality exists within the family, 2) whether or not there are multiple molecular weight classes per family, 3) whether or not they can be synthesized by carbocation rearrangement reactions, 4) whether or not they can be distilled at atmospheric pressure, or if a vacuum distillation is required, 5) whether or not they can be isolated by distillation alone, and what other types of materials are co-distilled in any particular distillate cut, and 6) whether or not all members of the family readily crystallize.

With regard to the number of structures per family, lower diamondoids have only a single, globular structure for each family; in other words, there is only one adamantane, one diamantane, and one triamantane. However, the higher diamondoids show multiple structural isomers within each family, including many shapes such as nanometer-sized straight rods, bent rods, discs, screws, etc. Furthermore, higher diamondoids exhibit multiple molecular weight classes when considering pentamantanes and larger diamondoids, whereas each of the lower diamondoids can be described by a single molecular weight class. This may be seen in reference to the following table, where the number of molecular weight classes increases with each successive higher diamondoid family:

Number of cage units	Number of molecular formulae	Higher diamondoid	Molecular weight							
			292	-	-	-	-	-	-	-
4	1	Tetramantane	292	-	-	-	-	-	-	-
5	2	Pentamantane	344	330	-	-	-	-	-	-
6	3	Hexamantane	396	382	342	-	-	-	-	-
7	4	Heptamantane	448	434	394	420	-	-	-	-
8	5	Octamantane	500	486	446	472	432	-	-	-
9	6	Nonamantane	552	538	498	524	484	444	-	-
10	7	Decamantane	604	590	550	576	536	496	456	-
11	8	Undecamantane	656	642	602	628	588	548	508	534

Furthermore, each of the lower diamondoids has been synthesized by equilibration reactions involving carbocation rearrangements, but higher diamondoids cannot be synthesized by these methods. In fact, only one higher diamondoid, [121] tetramantane, has ever been synthesized, and that by a complex and low-yielding process. Unsubstituted lower diamondoids demonstrate no chirality, whereas there are many unsubstituted higher diamondoids that exhibit chirality.

The lower diamondoids diamantane and triamantane of the WO 92/13909 reference are all (relatively) lower molecular weight compounds that can be isolated by distillations at atmospheric pressure. The higher diamondoids of the instantly claimed polymers, on the other hand, are C₂₂ and higher compounds, have atmospheric equivalent boiling points higher than 650° F, and thus can only be

distilled under vacuum conditions. In diamondoid-rich feedstocks, lower diamondoid distillate cuts are primarily just that, lower diamondoids, whereas higher diamondoid cuts contain large amounts of materials other than higher diamondoids, such as non-diamondoids and dimers of lower diamondoids linked by sulfur bridges. Also, higher diamondoids have a greater structural complexity than lower diamondoids (where complexity includes asymmetry) and show greater numbers of difficult-to-separate, naturally occurring alkylated analogs.

Lower diamondoids can be isolated by distillation alone. Higher diamondoids cannot be isolated by distillation alone: isolation of the higher diamondoids requires additional processing such as pyrolysis, hydroprocessing, and/or an additional separation step such as HPLC. All of the lower diamondoids have high melting points (> 225°C) and may be readily crystallized. However, some of the lower-symmetry higher diamondoids have lower melting-point members that do not readily crystallize.

The advantages of using the higher diamondoids in the instantly claimed polymers includes an extraordinarily large variation in size, shape, and molecular weight, even among members of any one homolog of the higher diamondoid series, which is contemplated to produce a correspondingly wide variation in the chemical and physical properties of the resulting polymers. These properties of the higher diamondoids include density, surface-to-volume ratio, carbon-to-hydrogen ratio, crystallographic orientation of exterior surfaces, the number and geometry of attachment sites, and degree of hydrogenation, to mention a few.

These advantages certainly could not be appreciated or suggested by the prior art, as the prior art is devoid of any means to isolate/obtain the instantly claimed higher diomondoid compounds and is also devoid of even correctly predicting their stoichiometric formulae.

Thus it is submitted that the higher diamondoids of the instantly claimed polymers are neither anticipated nor rendered obvious by the lower diamondoids of



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the WO 92/13909 reference. Favorable reconsideration and withdrawal of the Examiner's rejections of claims 65-85 over the WO 92/13909 reference are therefore respectfully requested.

CONCLUSIONS

It is believed that the term "higher" diamondoid as used in claims 65-85 is defined in the specification, and that the specification therefore does provide a standard for one of ordinary skill in the art to reasonably apprise the scope of the invention. In view of this, and since claims 65, 66, 67, 68, and 69 have been rewritten in independent form, favorable reconsideration and withdrawal of the Examiner's Section 112 rejections of claims 65-85 are therefore respectfully requested.

Since adamantane is not a higher diamondoid, it is submitted that claims 65-70 are not anticipated by the Chapman et al. reference (U.S. Pat. 5,053,434). Furthermore, it is submitted that the higher diamondoids of the instantly claimed polymers are neither anticipated nor rendered obvious by the lower diamondoids adamantane and triamantane of the WO 92/13909 reference for the reasons stated above. There are substantial differences between the higher and lower diamondoids that are not appreciated or suggested in the prior art. In view thereof, favorable reconsideration and withdrawal of the Examiner's Section 102(b) rejections of claims 65-70 over the Chapman et al. reference (U.S. Pat. 5,053,434), and the rejections of claims 65-85 over the WO 92/13909 reference to Mobil Oil, are therefore respectfully requested.

Respectfully submitted,
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